## CLAIMS

We claim:

1. A source-sensor unit for a magnetic susceptibility measuring instrument, comprising:

at least one applied-field generating element; and

at least one magnetic sensor;

wherein said at least one applied-field generating element and said at least one magnetic sensor are arranged such that the signal due to the applied field is canceled out; and

wherein said entire source-sensor unit is constructed in such a way that said cancellation of the applied-field signal is preserved as the entire source-sensor unit expands and contracts uniformly.

2. The source-sensor unit recited in claim 1, wherein said source-sensor unit is symmetrically constructed.

3. The source-sensor unit recited in claim 2, further comprising a single coil form, and wherein:

said at least one applied-field generating element comprises an applied-field coil;

said at least one magnetic sensor comprises two identical sensor coils;

said applied-field coil and said two sensor coils are co-axially wound on said single coil form with said applied-field coil centered between said two sensor coils; and

said two sensor coils are connected in series opposition to form a first-order magnetic gradiometer.

4. The source-sensor unit recited in claim 3, further comprising:

two thermally conductive links placed symmetrically with respect to the plane of mirror symmetry of said source-sensor unit; and

a heat sink placed symmetrically with respect to the plane of mirror symmetry of said source-sensor unit;

wherein said thermally conductive links connect said coil form to said heat sink.

5. The source-sensor unit recited in claim 4, further comprising a thermally insulating enclosure encasing said applied-field coil, said two sensor coils, and said coil form.

6. The source-sensor unit recited in claim 5, wherein said heat sink is outside said thermally insulating enclosure.

7. The source-sensor unit recited in claim 3, wherein said coil form is constructed to have significantly more mass than said applied-field coil and said sensor coils.

8. The source-sensor unit recited in claim 3, further comprising a large thermal mass in contact with said coil form, said applied-field coil, and said sensor coils.

9. The source-sensor unit recited in claim 8, wherein said coil form is constructed as a solid cylinder.

10. The source-sensor unit recited in claim 8, wherein said coil form is constructed as a thick-walled hollow cylinder.

11. The source-sensor unit recited in claim 1, wherein:

said at least one applied-field generating element comprises a plurality of applied field coils configured to generate magnetic fields which cancel each other in a region between said plurality of applied field coils; and

said at least one magnetic sensor is placed in said region of zero magnetic field between said plurality of applied field coils.

12. The source-sensor unit recited in claim 11, wherein:

said plurality of applied field coils comprise a plurality of printed circuit boards;

a central region of each said circuit board contains a number of parallel, evenly spaced traces;

said parallel traces on each said circuit board are connected in series, so that said parallel traces carry identical currents, approximating the effect of a uniform sheet of current in a central region of each said circuit board, with return paths completing the circuit along at least two edges of each said circuit board;

said plurality of circuit boards are connected in series, so that said currents are identical in all said circuit boards, and so that said currents flow in the same direction on said plurality of circuit boards; and

said at least one magnetic sensor is positioned between said plurality of circuit boards in said region of zero magnetic field.

13. The source-sensor unit recited in claim 12, further comprising identical layers of metal on both sides of each said circuit board.

14. The source-sensor unit recited in claim 12, wherein said circuit board and said trace are constructed of materials having substantially the same thermal expansion coefficients.

15. The source-sensor unit recited in claim 14, wherein:

said circuit board is constructed of fiberglass; and

said trace is formed of copper.

16. The source-sensor unit recited in claim 15, wherein said fiberglass is G-10 fiberglass.

17. The source-sensor unit recited in claim 15, wherein said fiberglass is FR-4 fiberglass.

18. The source-sensor unit recited in claim 1, further comprising structures defining the shapes, dimensions, and geometrical relationships of said at least one applied-field generating element and said at least one magnetic sensor, said structures being constructed of materials with low thermal expansion coefficients.

19. The source-sensor unit recited in claim 18, wherein said structures are constructed of a material selected from the group consisting of quartz, machinable glass-ceramic, marble, sapphire, and granite.

20. The source-sensor unit recited in claim 18, wherein said structures include a coil form for winding at least one applied-field coil and at least one sensor coil.

21. A method for performing pre-MRI screening, comprising:

providing a magnetic susceptibility measuring instrument having at least one applied-field generating element, and at least one magnetic sensor;

constructing the structures which define the shapes, dimensions, and geometrical relationships of said instrument of materials with low thermal expansion coefficients;

canceling the signal due to the applied field by arrangement of said applied-field generating element and said sensor;

preserving said cancellation of the applied-field signal as the entire source-sensor unit expands and contracts uniformly;

generating an applied magnetic field in a region of interest of a patient, with said source-sensor unit; and

generating a magnetic susceptibility measurement relevant to the presence or absence of a ferromagnetic foreign body in said region of interest, with said source-sensor unit.

22. The method recited in claim 21, further comprising constructing said structures which define the shapes, dimensions, and geometrical relationships of said instrument of a material selected from the group consisting of quartz, machinable glass-ceramic, marble, sapphire, and granite.

23. A method for performing pre-MRI screening for ferromagnetic foreign bodies, comprising:

providing a source-sensor unit including at least one applied-field generating element and at least one magnetic sensor;

canceling the signal due to the applied magnetic field at the location of said at least one magnetic sensor by the relative arrangement of said at least one applied-field generating element and said at least one magnetic sensor in said source-sensor unit;

preserving said cancellation of the applied-field signal as said entire source-sensor unit expands and contracts;

generating an applied magnetic field in a region of interest of a patient, with said source-sensor unit; and

generating a magnetic susceptibility measurement relevant to the presence or absence of a ferromagnetic foreign body in said region of interest, with said source-sensor unit.

24. The method recited in claim 23, further comprising preserving said cancellation of the applied-field signal by symmetrically constructing said entire source-sensor unit.

25. The method recited in claim 23, further comprising shielding said source-sensor unit from shifting air currents.

26. The method recited in claim 23, further comprising:

generating said applied magnetic field using electrical field coils;

providing a thermal link from said source-sensor unit to a point outside said shield to remove heat produced by ohmic losses in said field coils, via said thermal link; and

controlling the temperature of said external point to minimize temperature fluctuation in said source-sensor unit.

27. The method recited in claim 26, further comprising controlling the temperature by putting said thermal link in thermal contact with a large thermal mass.

28. The method recited in claim 26, further comprising controlling the temperature by putting said thermal link in thermal contact with a temperature-stabilizing system.

29. The method recited in claim 28, wherein said temperature-stabilizing system includes a chemical or physical phase transition substance selected from the group consisting of ice in water, butanol, and tertiary-butanol.

30. The method recited in claim 23, wherein said region of interest comprises an eye of the patient, said method further comprising rotating said eye, thereby moving said ferromagnetic foreign body to modulate the magnetic susceptibility signal from any ferromagnetic foreign body which may be present, without substantially changing the magnetic susceptibility response of the patient's body tissues.



31. The method recited in claim 30, further comprising rotating said eye in a controlled manner.

32. The method recited in claim 23, further comprising:

placing a bag of deformable material next to a body surface of the patient adjacent said region of interest; and

placing a rigid, fixed barrier in contact with said deformable bag, between said deformable bag and said source-sensor unit, thereby replacing the varying shapes of said body surface with an air/deformable-material interface of constant shape defined by said barrier.

33. The method recited in claim 32, wherein said deformable material is selected from the group consisting of water, aqueous solution, gel, or other suitable materal.

34. The method recited in claim 23, further comprising:

providing a plurality of said source-sensor units at a plurality of remote locations;

providing a central computer processing station;

transmitting a plurality of said magnetic susceptibility measurements generated by said remote source-sensor units to said central computer processing station via a communication system; and

interpreting said magnetic susceptibility measurements with said central computer processing station.

35. The method recited in claim 34, further comprising transmitting said plurality of said magnetic susceptibility measurements to said central computer processing station via the Internet.

36. The method recited in claim 34, further comprising providing real-time interactive feedback between said remote source-sensor units and said central computer processing station.

37. The method recited in claim 34, further comprising performing instantaneous autointerpretation of said magnetic susceptibility measurements using artificial intelligence.

38. The method recited in claim 34, further comprising performing instantaneous autointerpretation of said magnetic susceptibility measurements using a neural network.